REMARKS

Reconsideration of the application is respectfully requested for the following reasons:

1. Amendments to Claims/Rejection Under 35 USC §112, 1st Paragraph

Claims 1 and 9 have been amended to overcome the rejection under 35 USC §112, 1st Paragraph. In particular, claims 1 and 9 have been amended to clarify that the invention is to adjust oscillation mode wavelengths and IMS of the laser (by adjusting the radius of the laser), rather than a method of "using" the laser. This is consistent with the passage cited by the Examiner which reads "reducing the radius R of the PQR laser can achieve adjustment of the oscillation mode wavelength and the IMS of the PQR." Withdrawal of the rejection under 35 USC §112, 1st Paragraph, is accordingly requested.

2. Entry of Amendments after Final Rejection

The amendments are solely in response to the rejection under 35 USC §112, do not affect the scope of the claims, and therefore should not raise "new issues." At the very least, the reduce the number of issues for appeal. Entry and consideration of the amendments is accordingly requested.

3. Rejection of Claims 1-6 and 9-11 Under 35 USC §103(a) in view of Bae *et al.*, *Photonic Quantum Corral, Carrier Ordering, and Photonic Quantum Dot/Ring Device* (the Bae Publication) and Han *et al.*, *InGaAs-AlGaAs-GaAs Strained-Layer Quantum-Well Heterostructure Circular Ring Lasers* (the Han Publication)

This rejection is respectfully traversed on the grounds that neither the Bae publication nor the Han publication provides any teaching that ***increasing IMS***, or ***decreasing a number of oscillation modes***, will have any effect on power consumption.

Fig. 1 of the Bae publication, which is cited by the Examiner as teaching a relationship between power consumption and radius of a PQR laser, does not teach adjustment of the modal spacing of the laser. Instead, Fig. 1 simply points out that the

threshold current increases with device diameter (or radius)–*i.e.*, the bigger the laser, the more power it consumes. It is not apparent from this figure that adjustment of modal spacing, which is a much finer adjustment even though it is based on radius, will also have an effect on power consumption. In other words, Bae's teaching that threshold current increases with laser diameter is <u>not</u> suggestive of the claimed use of modal spacing (IMS) adjustment to reduce power consumption.

The IMS for a particular PQR laser having a diameter of 40 μm is shown in Fig. 6 of the present application. As shown in this figure, the IMS is about -0.2 nm/mode. According to the invention, this spacing is increased by varying the radius of the laser. It is not at all apparent from either Bae or Han that adjusting the radius of the laser will affect the IMS shown in Fig. 6 of the present application, or that such an adjustment is even desirable.

While it is true that the Han publication discloses adjusting the radius of a **2D ring laser** to adjust modal spacing, there is no suggestion in the Han publication that modal spacing of a **3D photonic quantum ring (PQR) laser** should be adjusted, much less that it should be adjusted by adjusting a radius of the laser to increase modal spacing (IMS) of the PQR laser as recited in claim 1, or to decrease the number of oscillation modes of the PQR laser as recited in claim 9. <u>The differences between a 2D ring laser and a 3D PQR laser are such that one of ordinary skill in the art would not have predicted, based on the ring laser radius-to-spacing relationship taught by Han, that adjustment of the radius could also be used in a PQR laser</u>. There are several reasons why the ordinary artisan would not have turned to Han's teachings concerning a ring laser when considering improvements to a PQR laser of the type claimed:

First, according to Han, <u>the mode spacing (1D) of the 2D ring laser of Han is proportional to the radius of the 2D ring laser, whereas the mode spacing of a PQR laser is actually *inversely* proportional to the radius of the PQR laser</u>. As explained in the Han publication:

. . .the measured longitudinal mode spacing of the 101um radius laser(~4Å) agrees well with the estimated value (3.9Å) of the high order whispering gallery modes for the corresponding ring radius, determined using the effective refractive index (neff=4.1) obtained from the mode spacing of Fabry-Perot lasers."(page 818, right below).

For example, a 21um radius laser with a 420 um-long waveguide has a mode spacing of 2.5 Å which is much smaller than expected for a high order whispering gallery mode (16.9 Å). The measured mode spacing corresponds to the mode spacing of a linear Fabry-Perot laser with a length of 448um which is close to the sum of the ring circumference and the coupling waveguide length."(page 819, left below).

According to Han, if the radius of the laser is 101 um, the mode spacing is 0.4 Å, and if the radius of the laser is 21 um, the mode spacing is 0.25 Å. Accordingly, the mode spacing (lD) of the ring laser of Han is proportioned to radius of the ring laser. In contrast, the mode spacing of the 3D photonic quantum ring laser of the present invention is inversely proportioned to radius of the 3D photonic quantum ring laser.

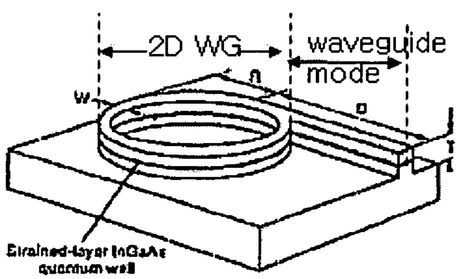


Fig. 1. Schematic diagram of an InGaAs–AlGaAs–GaAs strained-layer quantum-well heterostructure circular ring laser before polyimide planarization. For the structures of this work, the outer ring radius R is 1 ~ 251 μm, the waveguide width W is 6 μm, the etch depth T is ~ 1.9 μm, and the length D of the coupling waveguide is typically ~ 500 μm

Since the Han publication discloses the laser which is the sum of 2D the ring circumference and the coupling waveguide length (page 819, left below), the laser of Han is not same technical field with the three-dimensional photonic quantum ring laser of the present invention.

Second, a ring laser of type disclosed in Han has an emission wavelength formula that is totally different from that of a photonic quantum ring laser. A quantized emission wavelength formula of the photonic quantum ring laser is as follows:

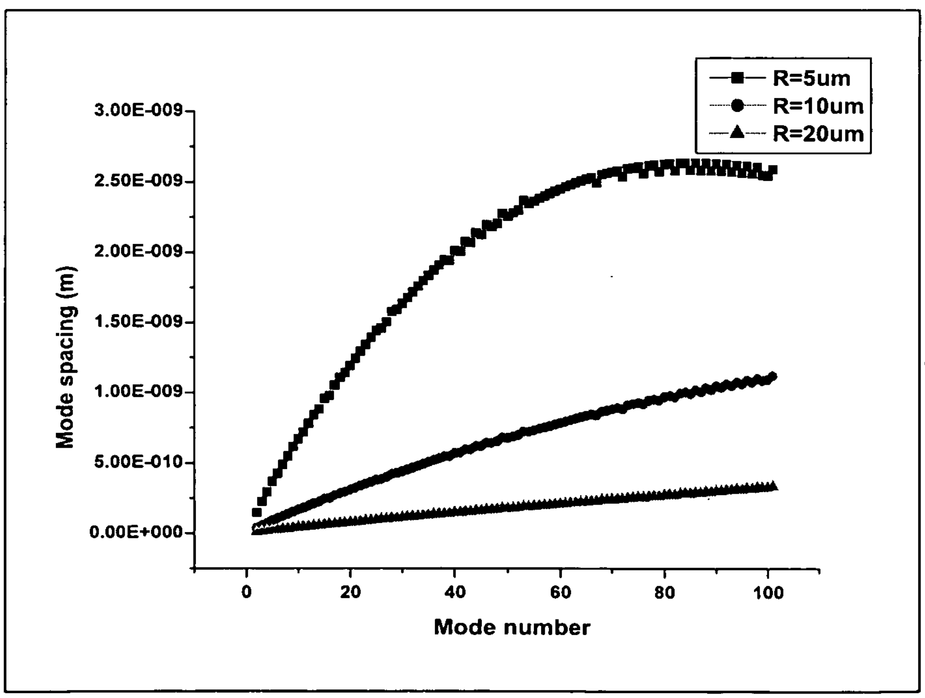
$$\lambda(m) := \frac{\lambda o}{\left[1 + \left[\frac{\lambda o \cdot x_m}{2 \cdot (3.14) \cdot R \cdot no}\right]^2\right]^{\frac{1}{2}}}$$ (see Applicant's specification, page 10)

In contrast, the quantized emission wavelength formula of a 2D ring laser of the type disclosed in the Han publication is as follows:

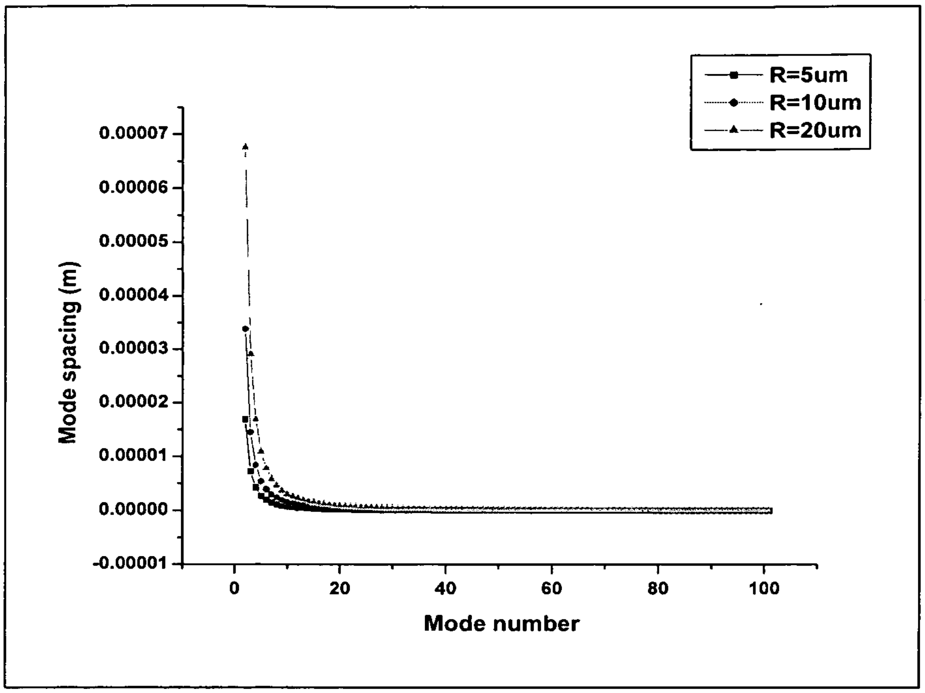
$$\lambda(m) := \frac{2\cdot(3.14)\cdot no\cdot R}{x_m}$$

(derived from $n_{eff}(w)Rw/c=\lambda_m^{(1)}$ shown in page 1310, of the article by R. E. Slusher, A. F. J. Levi, U. Mohideen, S. L. McCall, S. J. Peat-ton, and R. A. Logan, "Threshold characteristics of semiconductor microdisk lasers", 6 September 1993, American Institute of Physics, a copy of which is attached hereto as "Exhibit A." As a result, it can be seen that the **emission wavelength formula** for the ring laser is **totally different** from the photonic quantum ring laser of the present invention, and that there is **no obvious relationship between modal spacing in a PQR laser and a ring laser**.

The lack of an obvious relationship between modal spacing in a ring laser and modal spacing in a PQR laser can further be understood from the following are graphs showing the relationship between the mode number and the mode spacing satisfying above-mentioned formulas.(Another conditions are *Index no= 3.5 , R =5um, 10um or 20um, and λo = 850nm)*



3-Dimensional photonic quantum ring laser



2-Dimensional Ring Laser

According to the graph of the 3D photonic quantum ring laser, if the **radius** of the photonic quantum ring laser is **reduced**, the mode spacing of the photonic quantum ring laser **increases**. In contrast, according to the above graph of a 2D ring laser, if the radius of the photonic quantum ring laser is **reduced**, the mode spacing of the photonic quantum ring laser is decreases. ***Therefore, the effect of radius on the mode spacing of the claimed PQR laser is completely different from the effect of radius on the mode spacing of a ring laser as disclosed by Han, and it would not be obvious to apply the mode spacing teachings of Han to a PQR laser such as the one taught by Bae***. As a result, one of ordinary skill in the art would not have combined the teachings of Han and Bae to obtain the claimed invention, and withdrawal of the rejection of claims 1-6 and 9-11 under 35 USC §103(a) is requested.

Having thus overcome each of the rejections made in the Official Action, expedited passage of the application to issue is requested.

Respectfully submitted,

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